not only in an extending state but also in a contracting state. Even in the case where liquid containing a sedimenting material such as slurry is used, therefore, the sedimenting material can be prevented from sedimenting and stagnating in the extending and contracting portion of the bellows.--

REMARKS

Receipt of the office Action of September 24, 2002 is gratefully acknowledged.

The objection to Fig. 12 is noted. Fig. 12 and Fig. 11 have been corrected and the corrections submitted herewith for approval. Upon the examiner's approval, the formal drawings of Figs. 11 and 12 will be corrected.

The title of the invention has been changed to conform to the title suggested by the examiner.

The specification has been amended formally and in the process, the correction for page 30, line 15 has been made.

The abstract has been amended to conform it to the guidelines set forth in MPEP § 608.01(b).

Claims 1-6 were presented for examination and these were rejected as follows: (1) claims 1 and 4 under 35 USC 102(a) as anticipated by Thomin et al; (2) claims 1 and 4 as unpatentable under 35 USC 103(a) over Hope et al; and (3) claims 2, 3, 5 and 6 under 35 USC 1-3 over Hope et al in view of Eickmann. These rejections are respectfully traversed.

Nevertheless, claims 1-6 have been replaced by new claims 7- 12 which are believed to patentably distinguish over the art of record. Consider the following.

****

A bellows used for a pump (claims 7-9), an accumulator or the like (claims 10- 12) according to the present invention is made of PTFE (which cannot be formed by fusion), and which is appropriate for chemical liquids, pure water and slurry in chemical mechanical polishing (i.e., CMP), which are used in a semiconductor producing apparatus. The bellows is formed by cutting a cylindrically formed body. This formation yields a processed article whose tensile strength is extremely low. Moreover, the bellows has fine cut flaws which are peculiar to a cut-processed article by means of biting in a cutting process, thereby easily causing cracks to occur in the radial direction in a ridge-like portion (or mountain portion) and a valley-like portion.

In that case where a corner portion on an outer side of a mountain portion (or a valley-like portion) is rectangular, the rectangular portion functions as a reinforcing portion for a rigid body. In other words, according to the extension and contraction of the bellows, lamella portions are extended, whereby contraction bending stress is exerted on the mountain portion (or the valley portion). In this case, a rectangular reinforcement portion of the rigid body, whereby deformation is not applied to portions from a basal end of each lamella portion to the mountain portion (or the valley portion) thereof, are successively formed on the mountain portion (or the valley portion). As a result, a center portion of each lamella portion, which are relatively thinly formed between the mountain portion and the valley portion, can easily be bent, and stress exerted on the mountain portion (or the valley portion) is considerably shared by the center portion of the lamella portion. This can prevent the stress from concentrating on the top of the mountain portion (or the valley portion). Damage of the top such as occurrence of cracks can be prevented. (This is especially advantageous when used for liquid containing slurry.)

In many cases, the bellows pump has a structure wherein the bellows is

reciprocally driven by an air cylinder. However, an extension of the bellows is forcedly towed by an interlock member of the air cylinder. Moreover, the bellows is contracted by introducing high-pressure air to an inside of a pump operating chamber disposed outside the bellows so as to create a high-pressure condition in the inside of the operating chamber. Therefore, when it is contracted, a high external pressure load is applied to the bellows. However, in case of employing the bellows having the rectangular corner portions, the bellows itself receive the bending stress. In other words, when the bellows is extended, the lamella portion between the mountain portion and the valley portion can receive the bending stress. When the bellows is contracted, the stress of the lamella portion is relaxed. This effectively facilitates contraction of the bellows. That is, contraction of the bellows can be performed at higher pressure (or higher speed) than the air pressure required for contraction. The slurry liquid remaining in a recess portion (i.e., the valley portion) of the bellows can be effectively discharged to the outside of the recess portion from a microscopic point of view. From a macroscopic point of view, a pump pressure (i.e., discharge pressure of the slurry liquid) can be increased by a simple device of the bellows and even the slurry liquid whose specific gravity is high can be sufficiently discharged. (This can lead to a pump which is compact and whose discharge amount is very large. It is extremely preferable in the semiconductor field.)

The lower lamella portion is inclined downwardly toward the center axis. So, even when using a liquid containing a sedimenting material such as a slurry, it can prevent the liquid from stagnating in the recess portion (i.e., the valley portion) of the bellows when the pump stops.

In Thomin et al, the bellows 12 is made of metal, which is basically different from

the present invention. For example, in the semiconductor field, the metal material has a problem of corrosion so that it is impossible to use such a material. Moreover, the spring properties of the bellows 12 are enhanced by forming the mountain portion and the valley portion at an acute angle. As a result, the lamella portions are tapered downwardly toward the center axis. Tapering does not aim at discharging the slurry liquid. Judging from the relationship between the lowest recess portion of the bellows 12 and the skirt 17 shown in Fig. 2, a fold of the lowest portion of the bellows is inclined upwardly, and the skirt 17 is vertical to the bellows axis. In the case where slurry liquid remains, the slurry under the upwardly inclined fold flows to a vertical face of the skirt, and, as a result, is stored in the vertical face of the skirt. Thus, Thomin does not recognize discharge of the slurry, because a portion, where the slurry most easily piles in the skirt, is not tapered, but vertically shaped as the vertical surface.

Moreover, the mountain portion (or the valley portion) of the bellows 12 is set at an acute-angled. When lamella portions are extended by the extension of the bellows, distortion occurring in deformation is concentrated on only the mountain portion (or the valley portion). So, in case that it is made of a material such as PTFE whose tensile strength is extremely low, the bellows is cracked and damaged.

It is respectfully submitted that Thomin et al neither discloses nor suggests the present invention, especially, that the corner portion (i.e., edges of the folded portion) of the mountain portion and the valley portion is rectangular. Thomin et al does not include a description about the effects and merits obtained by the rectangular corner (i.e., edges of the folded portion of each of the ridge-like folds and valley-like folds being shaped to be angled).

The bellows of Hope et al is not basically different from Thomin et al from the

structural point of view.

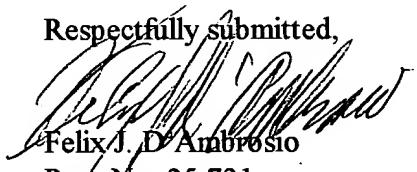
Hope et al neither discloses nor suggests the feature of the present invention, i.e., that the corner portion (i.e., edges of the folded portion) of the mountain portion and the valley portion is rectangular. Hope et al does not include a description about the effects and merits obtained by the rectangular corner (i.e., edges of the folded portion of each of the ridge-like folds and valley-like folds being shaped to be angled).

Eickmann is not a bellows pump which is open downwardly but one which is open upwardly. So, Eickmann does not confront and therefor provides no teaching for the avoidance of slurry stagnation. If the slurry liquid flows in the pump, slurry surely be stored in the bottom of the bellows. Moreover, in the bellows according to Eickmann et al a fold of the lowest portion of the bellows is inclined upwardly. Even in case of employing it as a bellows pump which is open downwardly, the effect of discharging the slurry according to the present invention cannot be obtained.

It is respectfully submitted, that there is no basis in Thomin et al for concluding that claims 1 and 4 are anticipated; and no basis in Hope et al or Hope et al and Eickmann for concluding that claims 1-6 are obvious.

In view of the foregoing, reconsideration and re-examination are respectfully requested and claims 7-12 (rewritten amended claims 1-6) found allowable.

Respectfully submitted,



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MARKED-UP COPY OF THE TITLE ON PAGE 1 OF THE SPECIFICATION

--FLUID APPARATUS HAVING DOWNWARDLY INCLINED LOWER LAMELLA PORTION OF A BELLOWS--

MARKED-UP COPY OF THE LAST TWO PARAGRAPHS ON PAGE 2 WHICH EXTENDS TO THE FIRST EIGHTEEN LINES ON PAGE 3 OF THE SPECIFICATION

--[The invention has been conducted in order to solve the problems. It is an object of the invention to provide a fluid apparatus which has a bellows, which is configured by a pump or an accumulator, and in which, even in the case where transported liquid containing a sedimenting material such as slurry is used, the sedimenting material can be prevented from stagnating and collecting in an extending and contracting portion of the bellows.]

Summary [Disclosure] of the Invention

It is an object of the invention to provide a fluid apparatus which has a bellows, which is configured by a pump or an accumulator, and in which, even in the case where transported liquid containing a sedimenting material such as slurry is used, the sedimenting material can be prevented from stagnating and collecting in an extending and contracting portion of the bellows.

The fluid apparatus having a bellows according to the invention is a fluid apparatus configured by a pump in which a bellows that has an extending and contracting portion configured by forming ridge-like folds and valley-like folds in a vertically alternate and continuous manner, and that is extendingly and contractingly deformable in an axial direction is placed in a pump body with setting an axis vertical to be driven to perform extending and contracting deformation, and form a liquid chamber inside the bellows, a suction port and a discharge port are formed in an inner bottom face of the pump body facing the liquid chamber, liquid is sucked from the suction port into the liquid chamber by extension of the bellows, and the liquid in the liquid chamber is

discharged from the discharge port by contraction of the bellows. In the fluid apparatus, the extending and contracting portion of the bellows is formed into a shape in which a lower one of upper and lower lamella portions of each of the ridge-like folds is downward inclined as moving toward the axis, not only in an extending state but also in a contracting state.--

MARKED-UP COPY OF THE FIRST AND FOURTH COMPLETE PARAGRAPHS ON PAGE 7 OF THE SPECIFICATION

--Fig. 13 is a section view taken along the line [F-F] 13-13 of Fig. 12.--

--Fig. 16 is a section view taken along the line [G-G] 16-16 of Fig 11.--

MARKED-UP COPY OF THE FIRST PARAGRAPH ON PAGE 8 OF THE SPECIFICATION

--Description of the Preferred Embodiment

[Best Mode for Carrying Out the Invention]

Fig. 1 shows a first embodiment in which the fluid apparatus having a bellows of the invention is applied to a pump.--

MARKED-UP COPY OF THE LAST PARAGRAPH ON PAGE 30 OF THE SPECIFICATION WHICH EXTENDS TO THE FIRST THIRTEEN LINES ON PAGE 31

--On the other hand, in the automatic air discharge valve mechanism 42, as shown in Fig. 11, an air discharge valve chamber 50 having a circular section shape, and an internal thread portion 78 having an inner diameter which is larger than that of the air discharge valve chamber 50 are formed in the rear end face of the valve case 37 so as to coaxially communicate with the air discharge port 40. The air discharge valve element 51 having a shape in which flat faces 51a are formed in opposing portions on the circumference as shown in Fig. [14] 16 is incorporated in the air discharge valve chamber 50 so as to be movable along the axial direction. The air discharge valve rod 53 is integrally coupled to the air discharge valve element 51. The air discharge valve rod 53 is passed through and held by a valve rod guide hole portion 79a so as to be slidable in the axial direction. The valve rod guide hole portion 79a is in the center of a discharge valve rod holder 79 which is screwingly fixed to the internal thread portion 78. In the air discharge valve rod holder 79, a plurality of communication holes 80 through which the air discharge valve chamber 50 communicates with the air chamber 32 are formed on the same circle that is centered at the valve rod guide hole portion 79a. A spring 81 through which the air discharge valve rod 53 is passed is interposed between the air discharge valve element 51 and the air discharge valve rod holder 79. The air discharge valve element 51 is always urged by the spring 81 so as to be in the closing position where the element is closely contacted with the valve seat 50a of the air discharge valve chamber 50. The air discharge valve element 51 is airtightly contacted with the valve seat 50a via an O-ring 82. As shown in Fig. 15, the O-ring 82 is fitted

into an arcuate groove 83 formed in a corner portion of the front end face of the air discharge valve element 51, whereby the O-ring is lockedly attached to the vale element.--

MARKED-UP COPY OF THE ABSTRACT

--ABSTRACT

[It is an object of the invention to, even in the case where transported liquid containing a sedimenting material such as slurry is used, prevent the sedimenting material from stagnating and collecting in an extending and contracting portion of a bellows. In order to attain the object, a] A bellows [7] that is extendingly and contractingly deformable in the axial direction is placed in a pump body [1 with setting the axis B of the bellows vertical so as to be driven to perform extending and contracting deformation,] and forms a liquid chamber [9] inside the bellows [7]. A suction portion [18] and a discharge portion [19] are formed in an inner bottom face [4a] of the pump body [1] facing the liquid chamber [9]. Liquid is sucked from the suction port [18] into the liquid chamber [9] by extension of the bellows [7], and the liquid in the liquid chamber [9] is discharged from the discharge portion [1] by contraction of the bellows [7]. The extending and contracting portion of the bellows [7] which is configured by forming ridge-like folds [71] and valley-like folds [72] in a vertically alternate and continuous manner is formed into a shape in which the lower one of upper and lower lamella portions [71a and 71b] of each of the ridge-like folds [71], or the lower lamella portion [71b] is inclined downwardly [inclined as moving] toward the axis defining the axial direction [B], not only in an extending state but also in a contracting state. Even in the case where liquid containing a sedimenting material such as slurry is used, therefore, the sedimenting material can be prevented from sedimenting and stagnating in the extending and contracting portion of the bellows [7].